

JAROSITE IN GALE CRATER, MARS: THE IMPORTANCE OF TEMPORAL AND SPATIAL VARIABILITY AND IMPLICATIONS FOR HABITABILITY. R.J. Léveillé¹, D.Z. Oehler², A.G. Fairén³, B.C. Clark⁴, P.B. Niles⁵, J.G. Blank⁶ ¹McGill University (richard.leveille@mcgill.ca), ²Jacobs / LZ Technology, NASA Johnson Space Center (dorothy.z.oehler@nasa.gov), ³Centro de Astrobiología & Cornell University (agfairén@cornell.edu), ⁴Space Science Institute (bclark@spacescience.org), ⁵NASA Johnson Space Center (paul.b.niles@nasa.gov), ⁶NASA/Ames Research Center & Blue Marble Space Institute of Science (jenifer.g.blank@nasa.gov).

The Curiosity rover has recently found evidence for small amounts of jarosite, a ferric sulfate, in the Pahrump Hills region at the base of Aeolis Mons (Mount Sharp), Gale crater. While jarosite has been described previously at other locations on Mars, including several sites at Meridiani Planum (explored by the Opportunity rover; [1, 2]) and Mawrth Vallis (by remote MRO-CRISM observations; [3]), this is the first identification in Gale. Jarosite is interpreted to be a mineral indicator of acidic conditions (pH < 4; [4]); on Earth, it is most commonly found in acid rock-drainage or acid sulfate soil environments [e.g., 5]. However, jarosite has also been described from a number of terrestrial environments where widespread acidic conditions are not prevalent [e.g., 6]. As a case study, we describe here an occurrence of sedimentary pyrite nodules that have been variably oxidized in situ to gypsum, schwertmannite, K-/Na-jarosite and iron oxides in a polar desert environment on Devon Island, Nunavut, Canada. Remarkably, these nodules occur in loosely consolidated carbonate sediments, which would have required a higher pH environment at their time of formation and deposition. Thus, acidic conditions may only exist at a small (sub-cm) scale or in a restricted temporal window in an otherwise well-buffered environment. On Devon Island, the jarosite occurs in the most oxidized nodules and is never associated directly with pyrite. Schwertmannite, a metastable iron oxyhydroxysulfate that can form at pH higher than that required for jarosite, occurs in association with partially oxidized pyrite. The paragenetic sequence observed here suggests initial formation of schwertmannite and late-stage precipitation of jarosite in restricted microenvironments, possibly forming via transformation of an amorphous schwertmannite-like phase (Figure 1). While the carbonate environment on Devon Island differs significantly from that of Gale crater, i.e., where we find predominantly basaltic sedimentary rocks [7, 8], this terrestrial analog provides insight into the significance of jarosite with respect to habitability. For example, the variable abundance of jarosite on Mars and possibly in Gale crater points to potentially localized conditions favorable for jarosite formation. Interestingly, small amounts of sulfide minerals have also been detected by Curiosity at Yellowknife Bay [9, 10]; oxidation of sulfide minerals at Pahrump could explain

the presence of small amounts of jarosite [10]. The iron-rich rocks at Pahrump may also represent relatively altered basaltic sediments [11], or they could be sediments that were altered further by a fluid with a distinct, possibly more acidic, composition. In addition, the abundance of iron-rich amorphous material in Gale rocks [9, 12] allows for the possibility that pre-cursor, iron-bearing phases transform to jarosite post-depositionally. Thus, the occurrence of jarosite at Pahrump could reflect changing paleoenvironmental conditions, though continuing study of its context and textural relationships should provide a fuller understanding of the significance of this mineral to past fluid compositions and past habitability at Gale crater.

References:

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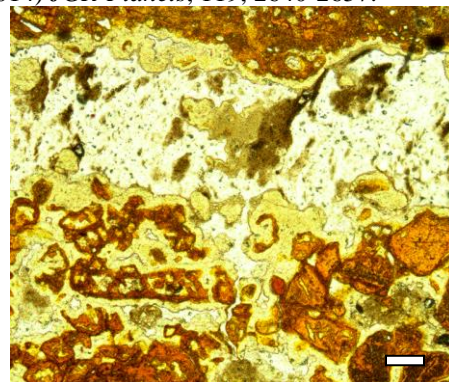


Figure 1. Thin-section photograph of completely oxidized pyrite nodule in Devon Island sample showing void-filling and late-stage jarosite (yellow) coating schwertmannite (orange). Scale bar is 100 micrometers.